TAILORED ARRIVALS TRIALS

Air Traffic Alliance, Boeing, Airservices Australia, QANTAS

NASA: 5th Integrated CNS Conference and Workshop

May 2-5, 2005

Mike WATSON

ATC Operational Support Manager, Thales ASD/ATMS

Presentation Topics

This presentation covers the following topic areas:

- **Theory behind the Project…**
- **What we have done…**
- **What we have found…**
- **Status And Next Steps**

Theory Behind The Project …

Purpose Of The Trial

To develop requirements for a new arrivals function that can use and exploit **EXISTING** airborne functionality.

To provide a transitional step towards ATM systems of the future (2015-2020), which will require new ground and airborne equipment.

- **A practical example of an application that will benefit from Trajectory Exchange**

TA expected benefits:

- More routine and frequent use of CDA will decrease fuel burn and carriage costs
- More predictable arrival operations will improve airline hub/spoke schedule adherence and schedule recovery
- Arrivals reflecting flight operational preferences of air carriers should yield air carriers operational savings

What is a Tailored Arrival?

A Tailored Arrival is a procedure that will:

- Allow ATS to utilize the current capabilities of existing aircraft Flight Management Systems (FMS) to provide an enhanced and more predictable ATM environment.
- Allow the FMS to recalculate vertical profile to meet sequencing adjustments prior to TOD, thereby reducing fuel burn, emissions and noise
- Reduce controller and pilot workload in situations where manual sequencing adjustments would otherwise be necessary.

Some Current Arrival Limitations

These include:

- Most current FMS cannot accurately meet a Required Time of Arrival (RTA) on descent, if descent has commenced prior to receiving the requirement.
- A STAR is a static procedure that generally requires vectoring off the path and/or relatively late speed changes to make adjustments.
- Current on-board navigation data base has limited capacity for stored arrival procedures.

By FMS =

RTA

If descent has commenced before an RTA is issued then:

SUCCESS = Throttles + Speed Brake = FUEL, NOISE, EMISSIONS

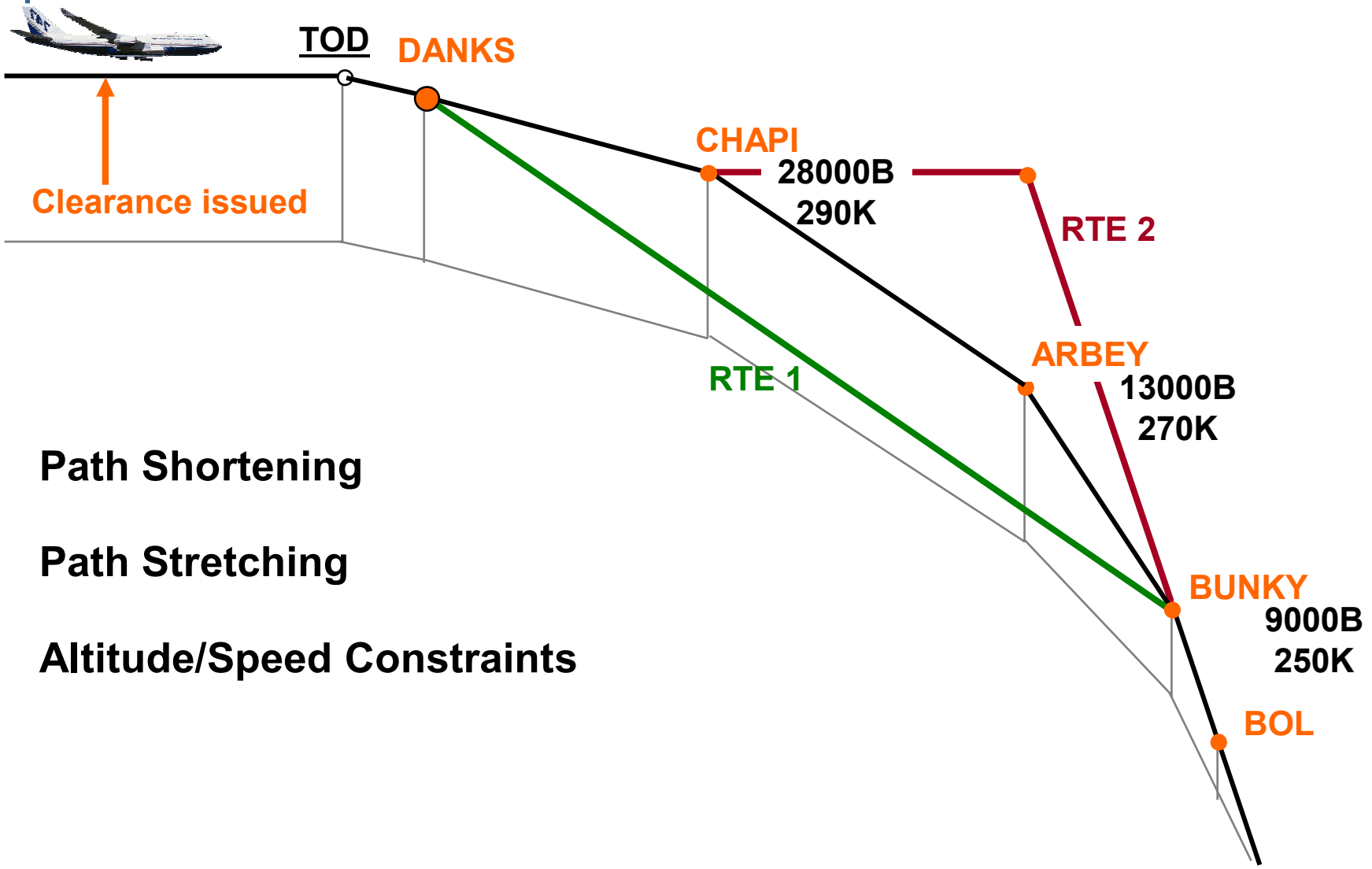
How Else to Achieve an RTA?

The FMS can accept:

- RNAV Routes
- Speed Constraints
- Altitude Constraints
- A combination of all three

Therefore we uplink a Route Clearance utilising the required elements to achieve the RTA.

Tailored Arrival Components



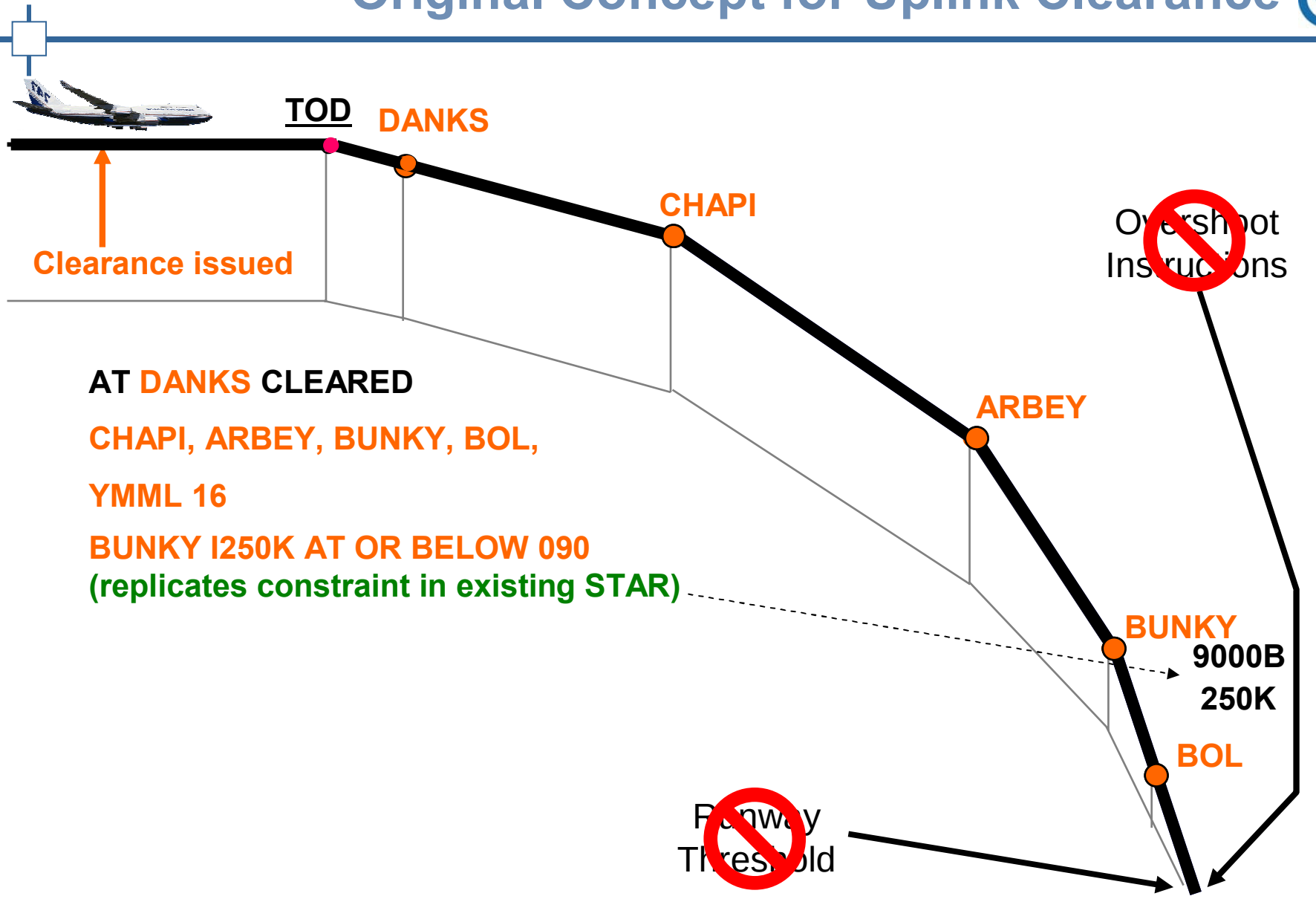
Path Shortening

Path Stretching

Altitude/Speed Constraints

What We Have Done …

Original Concept for Uplink Clearance



Actual Uplink Clearance

TOD

DANKS

CHAPI

Existing STAR

Clearance issued

AT DANKS CLEARED

CHAPI

ARB16 CHAPI

YMML 16

ARBEY I300K AT OR BELOW 110

Constraint already in STAR:
(BUNKY I250K AT OR BELOW 090)

ARBEY

11000B

300K

BUNKY

9000B

250K

BOL

Air Traffic Alliance

BOEING

THALES

What We Have Found …

FMC Time Predictions

Note:

FDP ETA on descent differed by up to 2 min. from the aircraft ETA.

This tended to align as surveillance data updated the FDP.

Accuracy Range:

From 2 to 40 seconds

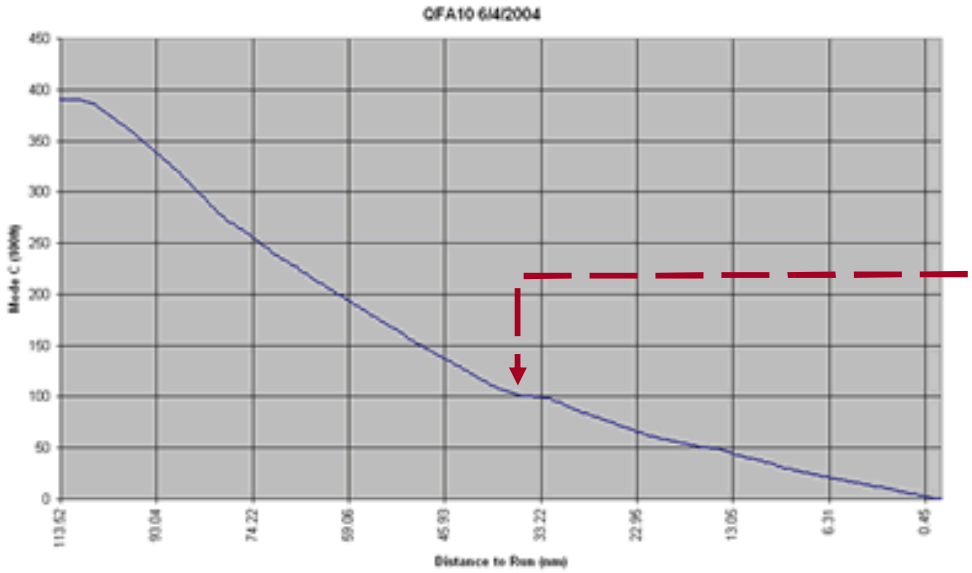
(MJW) TUG CAIRO April 2005

Air Traffic Alliance BOEING THALES

CDA Profile

B744

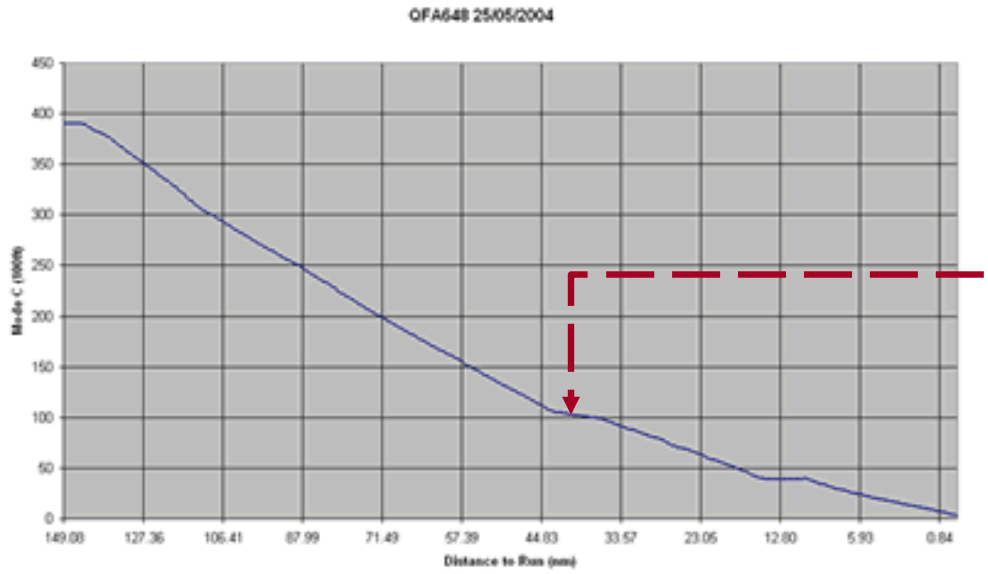
ML 16



FMC Adjustment

A330

ML 34



Air Traffic Alliance BOEING THALES

Some Specific Findings

	Boeing	Airbus	TAAATS
Constraints	Speed – At or Below	Speed – At or Below	TAS/IAS
	Alt only, Speed + Alt	Speed only, Alt only, Speed + Alt	
	Econ Speed	No Issue	
Names & RC	WEY716	WEN16	WENDY07 16
	No Issue (USAF – depends)	Destination	STAR & HMI Design
Times	RTA☺	RTA☺ ☺	
	ETA☺ ☺ ☺ ☺ ☺	ETA☺ ☺ ☺ ☺ ☺	ETA☺ ☺

Saving Navigation Database Capacity

New Division Of Arrival Procedures:

By making the STAR transitions and associated constraints part of the Tailored Arrivals clearance, the number of STAR components could be reduced, relieving pressure on database capacity.

Status And Next Steps

Phase 1 (Mar-Dec '04) has produced significant data and feedback on issues for the eventual operational implementation of TA type functionality:

- **The basic procedures proposed will work,**
- **Enabled extensive data collection,**
- **Identified some implementation and standardisation issues with existing systems as previously discussed.**

Phase 2 (Mar '05-Dec '06) is addressing the identified issues for the ground component and airborne system standardisation in order to validate that an operationally deployable system is viable. It will involve the building of a prototype based upon the Thales Eurocat product.

Phase 3 (Jan '07+) will address advanced TA applications and take advantage of next generation FMS capabilities.

TA Procedures

We see at least 2 phases for an operational TA system:

- **Initial (Phase 2): based upon a set of pre-defined procedures that allow selection of arrivals with defined delays or shortcuts,**
  - **Automatic or manual selection of tailored route,**
  - **Selection can be based upon AMAN outputs where available,**
  - **The Phase 2 solution needs to remain compatible with existing airborne capabilities.**
    - **It is possible that some modifications to the test bench avionics could be made but the end solution needs to be compatible with existing capabilities.**

- **Advanced (Phase 3): based upon automation of the TA definition per aircraft in real-time.**
  - **Computes a trajectory based upon AMAN outputs and a range of ATC constraints:**
    - **Conflict assessment, airspace constraints …**

The Nature Of Phase 2

The Phase 2 actions will be of a significantly different nature to Phase 1 due to the fact that software modifications will be required for the ground system components.

Phase 2 can be seen as the following steps:

- **Continued data collection via Phase 1 type tests (extended to Brisbane FIR)**
  - **Particularly to gain data on RTA management**
- **ATM System (EUROCAT) software modifications on Thales Datalink Test Bench**
- **End-to-End trials using Thales platform and connections to Airbus and Boeing test benches**
- **Limited live trials**
  - **There are additional safety and operational issues to address compared to TA Phase 1.**

Ground System Changes – Phase 2 (1/2)

Re-definition of approach procedures. Split into sub-components:

- STAR Transition Routes
  - **Transition segment is where most of the "TA work" should be done**
  - **Has "gain or lose time" variants**
  - **Not contained in on-board navigation database.**
- TA STAR
  - **Starts as close as possible to TMA entry**
  - **Has "gain or lose time" variants but only for fine tuning**
  - **Final Approach Procedure if STAR is runway specific**
  - **Procedure is contained in on-board navigation database.**
- Final Approach Procedure (FAP)
  - **Linked to runway**
  - **For use when STAR is not runway specific.**

The clearance could be composed of:

- (Points)+Transition+STAR+FAP translated into points+procedure useable by the aircraft.
  - **Ground System ensures airborne compatibility.**

Ground System Changes – Phase 2 (2/2)

Tools to implement TA functionality, including:

- Automatic and manual selection of proposed TA
- Use of Arrival Manager (AMAN) constraints
- Presentation of proposed routes to controllers

Enhancements to ground based Trajectory Prediction:

- Two areas of development will be undertaken as TA Enablers:
  - **Enhancement of ground Trajectory Prediction by aircraft intent data**
  - **Refinement of Meteorological Model through use of MET Group Data**

Investigate ways to automate reception of Top-Of-Descent from the aircraft.

Modifications to assist resolution of airborne issues:

- In RC message fill optional LAT/LONG field for the published points
- Intelligent internal procedure name aliases to cover navigation database inconsistencies

Airborne Considerations

Airborne Navigation Database standardisation (if possible within the timeframe):

- Common procedure names and definitions

Standardise use (or interpretation) of point type data.

How to provide accurate Top Of Descent to the ground system:

- Crew could enter TOD Lat/long as a waypoint but this may be cumbersome so look for alternative means.

Investigate the issues that may arise from the interpretation of speed constraints as “at or below” by FMS.

The Question – Operational When?

Phase 2 type capabilities – Most likely delivered in 2 steps:

- STEP 1: 2007
  - Automation of some existing procedures that will provide the foundation of TA capabilities but which can be done independently of the TA Phase 2 trials and outcomes.
- STEP 2: 2008-9
  - Full Phase 2 capabilities.
  - Industrialisation of the outputs of Phase 2.
  - Full validation processes.

Phase 3 type capabilities:

- Possibly 2012
  - Will involve airborne changes
  - Lots of conceptual and practical challenges to be met

End